

REMARKS/ARGUMENTS

The outstanding Office Action rejects all Claims 1-20 on various grounds and over five applied references (*Bonkabeta et al.* (US Pat Pub 2004/0188260 hereinafter "*Bonkabeta*"), *Taylor* (US Pat Pub 2003/0178315 hereinafter "*Taylor*"), *Reid et al.* (US Pat Pub 2001/0015321 hereinafter "*Reid*"), *Datta et al.* (USPN 5,567,300 hereinafter "*Datta*"), and *Zhou et al.* (USPN 6,402,931 hereinafter "*Zhou*"). Claims 18-20 are cancelled herein. Claims 1 and 7 are amended. The various grounds of rejection are discussed below. New Claims 21-26 are added. Claims 1-17 and 21-26 are now pending in this application.

One general comment is that none of the cited art has any appreciation of the problem in the cited art. None of the cited art has discovered or disclosed any appreciation of the "inverse" dishing metal layer profiles that are so problematic in modern polishing. This is the problem identified in the invention (See, e.g., Fig. 2 and the discussions pertaining thereto). A comparison of any of the dishing profiles in any of the cited art shows that all cited art believes that the problem lies with excess overpolishing in the center of the metallized trenches leaving healthy metallization built up at the edges of the trenches. Fig. 1 of *Taylor* being the quintessential example of this prior art way of thinking. High build up at the edges is what the prior art has been trying to solve ... until now. The claimed inventions teach a process where this edge build up is actually encouraged (in direct contradiction to the cited art). The claimed inventions deliberately build the edge profiles during deposition because the concentration of additives in the polishing portion of the process has an inverse profile (i.e., they etch away material more aggressively at the edges rather than in the middle of a trench) which when carefully balanced can generate a more flat final profile in the trenches. This appreciation and understanding of the problem and the carefully balancing of processes to solve the problem are entirely absent from all cited art. In fact, all references teach away from the claimed invention.

Rejection Under 35 U.S.C. § 102

Claims 1-4, 6, 7, 16, and 18-20 have been rejected under 35 U.S.C. § 102(b) as being anticipated by *Lee*.

In short order, Applicants cancel Claims 18-20 thus a discussion of these claims is moot. Accordingly, Applicants request that the rejection of these claims be withdrawn.

As to Claims 1-4, 6, 7, and 16, the Applicants have amended Claims 1 and 7 and hereby traverse the pending anticipation rejection.

As to amended Claim 1, the Applicants respectfully traverse this rejection on the following grounds:

Claim 1 recites "planarizing the metal layer by implementing passes of ... electropolishing followed by electroplating wherein the passes begin having ratio of electropolishing rate to electroplating rate that is about 1.5 and as the planarizing continues the ratio of electropolishing rate to electroplating rate for subsequent passes is reduced to a ratio of about one". Such a gradual reduction of the plating/polishing rates in each pulse is not taught by *Bonkabeta*. Absent this limitation, the cited art does not teach all limitations of Claim 1 and is therefore unable to anticipate Claim 1. Accordingly, because the cited art fails to teach all claim elements of the claimed invention, the cited art does not establish a *prima facie* case for anticipation and is therefore insufficient to establish a rejection under 35 U.S.C. § 102. Therefore, the Applicants respectfully request that this ground of rejection be withdrawn as to Claim 1 and the claims depending therefrom (Claims 2-6 and 10-17).

As to Claim 7, this claim has been amended only in that it was necessary to make the claim independent (i.e., it incorporated the limitations of the base Claim 1, nothing more). It is not clear that the cited art teaches as relation step as claimed. Therefore, the Applicants respectfully request that this ground of rejection be withdrawn as to Claim 7.

The anticipation rejections of Claims 18-20 in view of *Taylor* have been discussed above. Accordingly, the Applicants respectfully submit that the rejections of the cited art have been overcome and are in condition for allowance.

Accordingly, it is respectfully submitted that these grounds of rejection be withdrawn as to rejected Claims 1-4, 6, 7, and 16.

Rejections Under 35 U.S.C. § 103

Claims 5, 8, 9 and 17 stand rejected under 35 U. S. C. §§ 103(a) as being unpatentable over *Bonkabeta* in view of *Taylor*.

Applicants respectfully traverse this rejection as well. Applicants have already pointed out the deficiencies of the *Bonkabeta* reference as to base Claim 1. Nothing additional provided by the added cited portions of *Taylor* correct the deficiencies of *Bonkabeta*.

As to Claim 5, the cited art fails to teach or suggest that "the passes begin having ratio of electropolishing rate to electroplating rate that is about 1.5 and as the planarizing continues the ratio of electropolishing rate to electroplating rate for subsequent passes is reduced to a ratio of about one". These elements are missing from the cited portions of *Taylor* (e.g., pghs. [0035],[0036]) as well as *Bonkabeta*. Additionally, the cited combination of references does not teach or suggest controlling the polish/plate ratios so that the "removal rate of electropolishing is controlled to be equal to that of the electroplating when the polishing exposes the substrate". No portion of either reference has been identified to teach matched (1:1) plating/polishing rates once the substrate is exposed. This is not surprising because none of the cited art has discovered the inverse dishing problem identified in the invention. Accordingly, the cited art is not likely to appreciate the need for such a step. A comparison of any of the dishing profiles in any of the cited art shows that all cited art believes that the problem lies with overpolishing in the center of the metallized trenches (i.e., polishing excessively removes material from the center of the trench without removing enough from the edge portions (Fig. 1 of *Taylor* being the quintessential example of this prior art way of thinking) rather than the problem of overpolishing at the trench walls which is shown as the problem in the present invention (See, for example, the metal profile in Fig. 2 of the instant Specification). It is perhaps more appropriate to say that the cited combination teaches away from the invention. To the extent the art says otherwise, the Examiner is invited to point out the relevant teachings of the prior art relied upon with reference to the column and line numbers (See, MPEP 706.02(j)(A)). Accordingly, for at least the reasons discussed above, it is submitted that a *prima facie* case of obviousness has not been established with respect to Claim 5. Consequently, the Applicants respectfully request that this ground for rejecting Claim 5 be withdrawn.

As to Claim 17 (which depends from Claims 1 and 2), the same arguments are applicable here. Accordingly, for at least the same reasons as expressed above with respect to Claim 1, it is submitted that a *prima facie* case of obviousness has not been established with respect to Claim 1. Consequently, the Applicants respectfully request that this ground for rejecting Claim 1 be withdrawn.

As to Claims 8 and 9, much the same argument applies as is set forth above with respect to Claim 5 can be applied. But, particularly, Applicants point out that the cited art does not teach or suggest that "the ratio of the electropolishing to electroplating rates in the first of the at least two passes is about 1.5 and the ratio of the electropolishing to electroplating rates in the last of the at least two passes is about 1" (Claim 8) or that "the ratio of the electropolishing to plating rates in the first of the at least two passes is about 1.5 and the ratio of the electropolishing to electroplating rates in the last of the at least two passes is about 1, wherein the electropolishing to electroplating rates progressively decreases from the first to the last of the at least two passes." (Claim 9). Absent this teaching, the cited art fails to establish a *prima facie* case of obviousness as to the rejected Claims 8 and 9. Therefore, the Applicants respectfully submit that the cited references are insufficient to establish that the claimed invention is obvious. Accordingly, the Applicants respectfully request that the pending ground of rejection be withdrawn.

Claims 10-14 stand rejected under 35 U. S. C. §§ 103(a) as being unpatentable over *Bonkabeta* in view of *Reid*.

Applicants respectfully traverse this rejection as well. Applicants have already pointed out the deficiencies of the *Bonkabeta* reference as to amended base Claim 1. Nothing additional provided by the added cited portions of *Reid* corrects the deficiencies of *Bonkabeta*.

As to Claims 10-14, the Applicants respectfully traverse this rejection on the following grounds:

The cited art does not teach or suggest "planarizing the metal layer by implementing passes of ... electropolishing followed by electroplating wherein the passes begin having ratio of electropolishing rate to electroplating rate that is about 1.5 and as the planarizing continues the ratio of electropolishing rate to electroplating rate for subsequent passes is reduced to a ratio of about one". Such a gradual reduction of the plating/polishing rates in each pulse is not taught by *Bonkabeta* nor is it taught in *Reid*. In fact, *Reid* does not address the issue of surface planarization at all. The *Reid* reference is directed to a plating process, not a planarization of an

existing deposited layer. Thus, its parameters are of no relevance. There is no motivation to combine a standard deposition process with the *Bonkabeta* reference to teach a planarization process. Thus, the cited combination of references fails to teach all limitations of the invention and fails to provide a valid motivation to combine the references. Accordingly, because the cited art fails to teach all claim elements of the claimed invention, the cited art does not establish a *prima facie* case for obviousness. Moreover, the cited references fail to provide a valid motivation to combine *Bonkabeta* with *Reid* and are therefore insufficient to establish a rejection under 35 U.S.C. § 103. Therefore, the Applicants respectfully request that this ground of rejection be withdrawn as to Claims 10-14.

Claim 15 is rejected under 35 U. S. C. §§ 103(a) as being unpatentable over *Bonkabeta* in view of *Datta*. Applicants respectfully traverse this rejection as well. Applicants have already pointed out the deficiencies of the *Bonkabeta* reference as to amended base Claim 1 upon which Claim 15 depends. Nothing additional provided by the added cited portions of *Datta* corrects the fundamental deficiencies of *Bonkabeta*. For example, neither *Bonkabeta* nor *Datta* teaches or suggests "planarizing the metal layer by implementing passes of ... electropolishing followed by electroplating wherein the passes begin having ratio of electropolishing rate to electroplating rate that is about 1.5 and as the planarizing continues the ratio of electropolishing rate to electroplating rate for subsequent passes is reduced to a ratio of about one". Such a gradual reduction of the plating/polishing rates in each pulse is not taught by *Bonkabeta* nor is it taught in *Datta*. Thus, the cited combination of references fails to teach all claim elements of the claimed invention and therefore does not establish a *prima facie* case for obviousness. Therefore, the Applicants respectfully request that this ground of rejection be withdrawn as to Claim 15.

Claims 1-9 and 15-17 stand rejected under 35 U. S. C. §§ 103(a) as being unpatentable over *Taylor* in view of *Zhou*.

Applicants respectfully traverse this rejection as well. These references are insufficient for the reasons already discussed below. In particular, the cited art demonstrates a fundamental lack of appreciation of the basic problem solved, and hence fails to teach a valid solution to the problem. Additionally, the cited art is missing numerous claim elements. Most of these failings have been touched on in the discussion of Claim 5 but will be addressed here as well.

As to Claim 1, the cited art fails to teach or suggest that “the passes begin having ratio of electropolishing rate to electroplating rate that is about 1.5 and as the planarizing continues the ratio of electropolishing rate to electroplating rate for subsequent passes is reduced to a ratio of about one”. These elements are missing from the cited portions of *Taylor* (e.g., pgs. [0035],[0036]) and are not addressed in *Zhou*. Additionally, there is no motivation to combine the teachings of *Zhou*, which refers to processes for machining hard high-strength metals (*Zhou* 1:32-45) on a large scale (on the order of millimeters, See, *Zhou* e.g., at 1:56-2:16) with planarizing semiconductor wafers on an Angstrom scale (*Taylor*).

Additionally, the Applicants point out that the cited combination of references does not teach or suggest controlling the polish/plate ratios so that the “removal rate of electropolishing is controlled to be equal to that of the electroplating when the polishing exposes the substrate”. No portion of either reference has been identified to teach matched (1:1) plating/polishing rates once the substrate is exposed. This is not surprising because none of the cited art has discovered the inverse dishing problem identified in the invention. This problem is not appreciated in *Taylor* and absolutely beyond the scope of *Zhou*, which is directed to a completely inapplicable technology area. Accordingly, the cited art is not likely to appreciate the need for such a process as claimed.

Again, comparison of the dishing profiles in *Taylor* shows that it believes that the problem lies with overpolishing in the center of the metallized trenches (i.e., polishing excessively removes material from the center of the trench without removing enough from the edge portions (Fig. 1 of *Taylor*)) rather than the problem of overpolishing at the trench walls, which is shown as the problem in the present invention (See, for example the metal profile in Fig. 2 of the instant Specification). *Zhou* offers no help in this area. In fact, no person of ordinary skill in the semiconductor planarization arts would be looking to metal deburring processes for a solution to his nano-scale semiconductor problems. Accordingly, for at least the reasons discussed above, it is submitted that a *prima facie* case of obviousness has not been established with respect to Claim 1 (or any claims depending therefrom). Consequently, the Applicants respectfully request that this ground for rejecting Claims 1-9 and 15-17 be withdrawn.

Claims 10-14 stand rejected under 35 U. S. C. §§ 103(a) as being unpatentable over *Taylor* in view of *Reid*.

Applicants respectfully traverse this rejection as well. Applicants have already pointed out the deficiencies of the *Taylor* reference with respect to base Claim 1 immediately above. Nothing additional provided by the added cited portions of *Reid* corrects the deficiencies of *Taylor*.

As to Claims 10-14, the Applicants respectfully traverse this rejection on the following grounds. The cited art does not teach or suggest "the passes begin having ratio of electropolishing rate to electroplating rate that is about 1.5 and as the planarizing continues the ratio of electropolishing rate to electroplating rate for subsequent passes is reduced to a ratio of about one". Such a reduction of the plating/polishing rates in each pulse is not taught by *Taylor* nor is it taught in *Reid*. In fact *Reid* does not address the issue of surface planarization at all. The *Reid* reference is directed to a plating process, not a planarization of an existing deposited layer. Thus, its parameters are of no relevance. There is no motivation to combine a standard deposition process with the *Taylor* reference to teach a planarization process. Thus, the cited combination of references fails to teach all limitations of the invention and fails to provide a valid motivation to combine the references. Accordingly, because the cited art fails to teach all claim elements of the claimed invention, the cited art does not establish a *prima facie* case for obviousness. Moreover, the cited references fail to provide a valid motivation to combine *Taylor* with *Reid* and are therefore insufficient to establish a rejection under 35 U.S.C. § 103. Therefore, the Applicants respectfully request that this ground of rejection be withdrawn as to Claims 10-14.

New Claims:

Claims 21-26 have been added to specifically clarify certain patentable subject matter.

In one representative example, Claim 21 recites numerous features not suggested by the cited art. For example, Claim 21 recites "planarizing the metal layer to compensate for excessive trench corner polishing", a feature unknown in the cited art. Also, "electro-polishing being conducted such that localized polishing rates inside the trenches at the corners of the trenches are greater than the localized polishing rates in the middle of the trenches resulting in a metal removal profile that removes metal at greater rate at the corner of the trenches relative to a metal removal rate in the middle of the trenches". Also, "the electroplating being conducted such that localized plating rates inside the trenches at the corners of the trenches are greater than the localized plating rates in the middle of the trenches resulting in a metal deposition profile

having a thicker metal layer at the corner of the trenches relative to the metal layer in the middle of the trenches", another feature clearly not suggested by the cited art. In fact, all teachings of the cited art are to the contrary. Each of the dependent claims further clarifies novel aspects of the invention. In addition, attention is drawn to Claims 25 and 26, which claim the particularly helpful attributes of the organic additive "bis (3-sulfopropyl) disulfide."

Moreover, the underlying art is believed to be insufficient to establish rejections of the new claims for the additional reasons discussed above with respect to the other claims.

Conclusion:

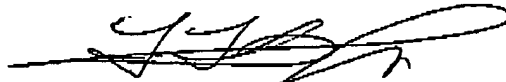
In view of the foregoing amendments and remarks, it is respectfully submitted that the claimed invention as presently presented is patentable over the art of record and that this case is now in condition for allowance.

Accordingly, the Applicants request withdrawal of all pending rejections and request reconsideration of the pending application and prompt passage to issuance. As an aside, the Applicants clarify that any lack of response to any of the issues raised by the Examiner is not an admission by the Applicants as to the accuracy of the Examiner's assertions with respect to such issues. Accordingly, the Applicants specifically reserve the right to respond to such issues at a later time during the prosecution of the present application, should such a need arise.

As always, the Examiner is cordially invited to telephone the Applicants' representative to discuss any matters pertaining to this case. Should the Examiner wish to contact the undersigned for any reason, the telephone number set out below can be used.

Additionally, if any fees are due in connection with the filing of this Amendment, the Commissioner is authorized to deduct such fees from Deposit Account No. 12-2252 (Order No. 03-1498).

Respectfully submitted,
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